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REPORT FOR CONSULTATION ON THE METROPOLITAN MEMPHIS INTERSTATE AIR QUALITY CONTROL REGION (ARKANSAS-MISSISSIPPI-TENNESSEE)

National Air Pollution Control Adminsitration
Washington, D.C.

December 1969

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REPORT FOR CONSULTATION

ON THE

METROPOLITAN MEMPHIS

INTERSTATE AIR QUALITY CONTROL REGION

(ARKANSAS-MISSISSIPPI-TENNESSEE)

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

December 1969

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PREFACE

The Clean Air Act as amended directs the Secretary of Health, Education, and Welfare to designate "air quality control regions" to provide a basis for the adoption of regional air quality standards and the implementation of those standards. The act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities. This report is intended to serve as background material for the consultation. It proposes boundaries for the Memphis Interstate Air Quality Control Region and discusses the factors which are the basis of the boundary proposal.

The Region* boundaries proposed in this report reflect consideration of available and pertinent information. However, the proposed boundaries remain subject to revisions suggested during consultation with State and local authorities. Formal designation of a Region will be made only after a careful review of all opinions and suggestions submitted during the consultation process.

The National Air Pollution Control Administration appreciates assistance received from the States of Mississippi, Arkansas, and Tennessee, and from the several planning agencies in the Region.

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*For the purposes of this report, the word "region", when capitalized, will refer to the Memphis Interstate Air Quality Control Region.

INTRODUCTION

THE REGIONAL APPROACH

Air pollution in the urban areas of the United States is a regional problem which frequently extends across State and local governmental boundaries. Since air pollution problems are rarely confined to any single municipality or county, successful control requires coordinated planning, standard setting, and enforcement by the several political jurisdictions which share a common problem. At the present, State and local governments across the Nation have only begun to develop a regional approach to air pollution control.

The Clean Air Act as amended provides a regional approach which depends upon coordination and cooperation between all levels of government; municipal, county, State, and Federal. To set in motion the machinery for regional air pollution control, the Department of Health, Education, and Welfare first designates air quality control regions, issues air quality criteria, and publishes reports on control techniques. The region designation indicates which State and local jurisdictions will be involved in a regional air pollution control effort. The air quality criteria indicate the extent to which various concentrations of an air pollutant are harmful to health and damaging to property. The reports on control techniques provide information on the costs and effectiveness of various techniques for controlling air pollutant emissions.

After the Department of Health, Education, and Welfare completes these initial steps, State governments develop air quality standards

and plans for implementation of those standards for areas within an air quality control region. An air quality standard defines the desired limit on the concentration of a pollutant in the ambient air of the region. It constitutes the degree of air quality which the regional control program will attempt to achieve. An implementation plan is a blueprint of the steps which will be taken to insure achievement of the air quality standards within a reasonable time. The Governors have 90 days from the time they are furnished the criteria and control technology reports by the Department of Health, Education, and Welfare to submit letters indicating that they intend to set standards. They have an additional 180 days to set the standards, and another 180 days to develop plans for implementing the standards. The procedure for setting standards includes a public hearing which allows residents of a region to express their views concerning desired standards.

The Department of Health, Education, and Welfare reviews air quality standards and implementation plans in order to ascertain their consistency with the provisions of the Clean Air Act as amended.

When air quality standards and implementation plans are approved, States proceed to prevent and control air pollution in accordance with those standards and plans. This system for establishing a regional approach to air pollution control is outlined in Figure 1.

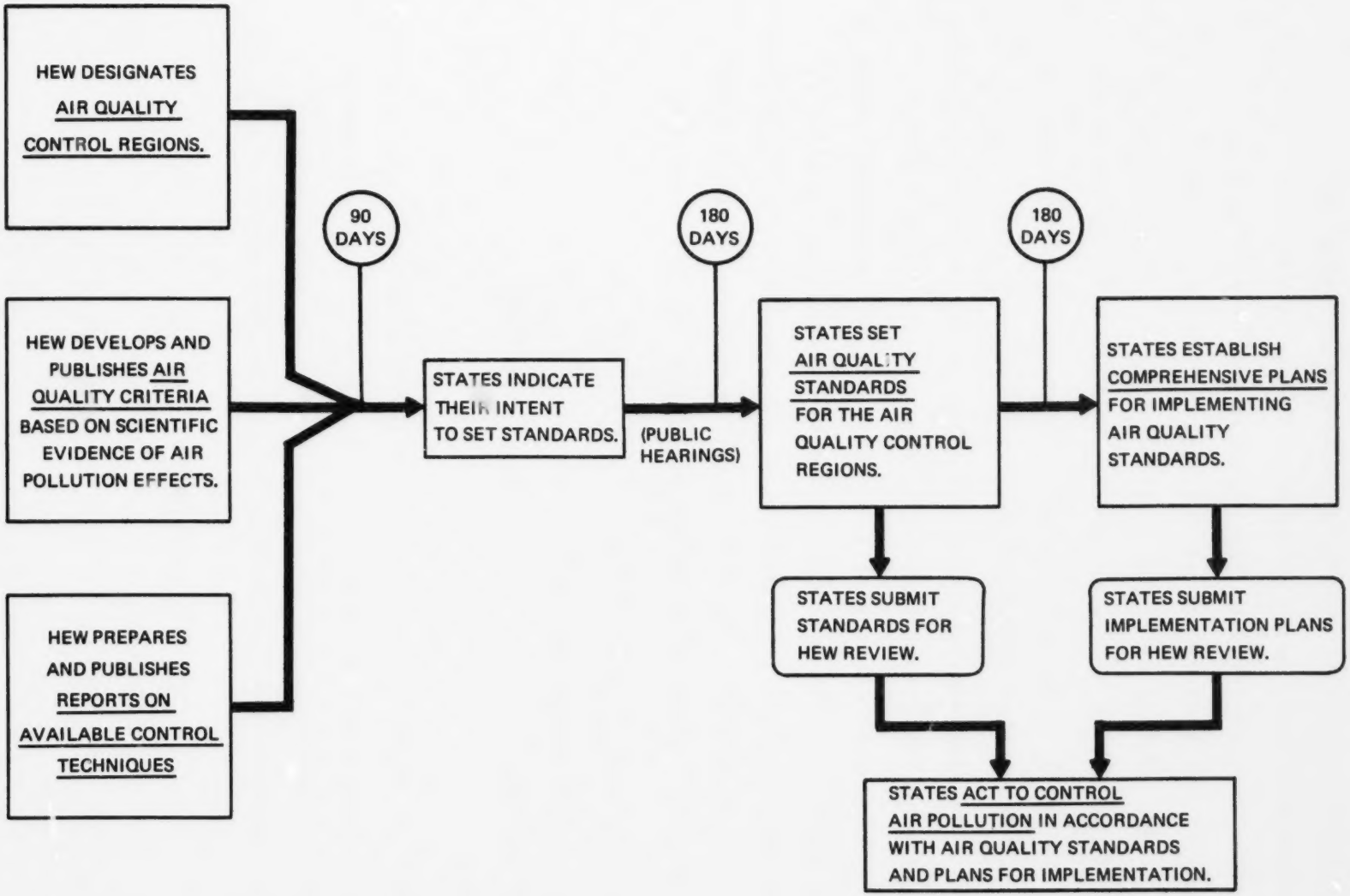

HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
(PUBLIC HEARINGS)
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

DESIGNATION OF AIR QUALITY CONTROL REGIONS

Designation of an air quality control region is one of the first steps in the regional approach to air pollution control. Section 107 (a) (2) of the Clean Air Act as amended directs the Secretary, Department of Health, Education, and Welfare to make such designations. The portions of the section relevant to this discussion state:

> "...The Secretary, after consultation with appropriate State and local authorities shall...designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may... revise the designation of such regions...The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."

Procedure For Designation of Regions

Figure 2 illustrates the procedures used by the National Air Pollution Control Administration for designating air quality control regions.

After evaluating relevant technical and urban factors, the National Air Pollution Control Administration publishes a proposed delineation of the region boundaries. At the same time NAPCA sets a time and place for a consultation meeting and distributes to State and local authorities a report of the evaluation study (such as this "Report for Consultation") which includes the boundary proposal. At the consultation meeting State and local authorities are encouraged to present fully their views and suggestions concerning the proposed boundaries of the region. Interested parties who do not have official status may submit comments in written form for

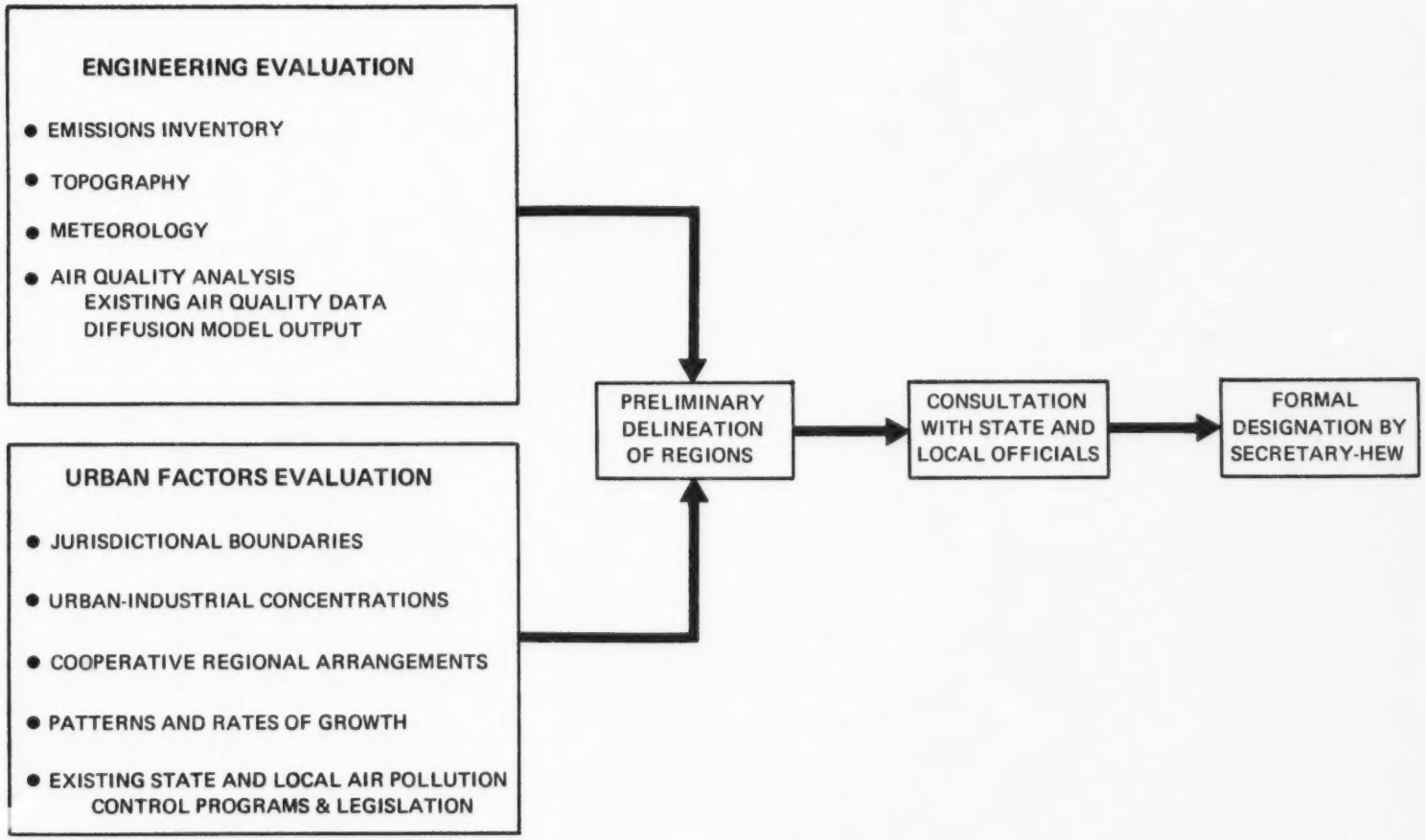

ENGINEERING EVALUATION
• EMISSIONS INVENTORY
• TOPOGRAPHY
• METEOROLOGY
• AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
DIFFUSION MODEL OUTPUT
URBAN FACTORS EVALUATION
• JURISDICTIONAL BOUNDARIES
• URBAN-INDUSTRIAL CONCENTRATIONS
• COOPERATIVE REGIONAL ARRANGEMENTS
• PATTERNS AND RATES OF GROWTH
• EXISTING STATE AND LOCAL AIR POLLUTION CONTROL PROGRAMS & LEGISLATION
PRELIMINARY DELINEATION OF REGIONS
CONSULTATION WITH STATE AND LOCAL OFFICIALS
FORMAL DESIGNATION BY SECRETARY-HEW

Figure 2. FLOW DIAGRAM FOR THE DESIGNATION OF AIR QUALITY CONTROL REGIONS.

the record. After careful review of all suggestions and opinions submitted for the record by interested parties, the Secretary of Health, Education, and Welfare makes a formal designation of the region boundaries and notifies the Governors of the designation.

The Size of a Region

As stipulated in Section 107 (a) (2), the designation of air quality control regions should be based on "jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards." This language suggests a number of objectives which are important in determining how large an air quality control region should be. Basically, these objectives can be divided into three separate categories.

First, a region should be self-contained with respect to air pollution sources and receptors. In other words, a region should include most of the important sources in the area as well as most of the people and property affected by those sources. In this way, all the major elements of the regional problem will lie within one unified administrative jurisdiction. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained. The air over a region will usually have at least trace amounts of

pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level trace effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect" will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative influence than short term data on episodic conditions.

The second general objective requires that region boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where industrial and residential expansion are likely to create air pollution problems in the foreseeable future. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation of regions which will contain the sources and receptors of regional

air pollution for a number of years to come. Of course, region boundaries need not be permanently fixed, once designated. Boundaries should be reviewed periodically and altered when changing conditions warrant readjustment.

The third objective is that region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Air pollution is a regional problem which often extends across several municipal, county, and even state boundaries. Clearly, the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem. Therefore, the region should be delineated in a way which encourages regional cooperation among the various governmental bodies involved in air pollution control. In this regard, the existing pattern of governmental cooperation on the whole range of urban problems may become an important consideration. Certainly the pattern of cooperation among existing air pollution control programs is a relevant factor. In general, administrative considerations dictate that governmental jurisdictions should not be divided. Although it would be impractical to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this would be impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region

must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

As noted above, the evaluation of relevant technical factors and urban factors forms the basis of the boundary proposals published by NAPCA. The evaluation of technical factors is designed to indicate the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by taking an inventory of emissions from power generation, industrial activities, space heating, waste disposal, and other pollution generators. The transport and distribution of pollutants in the ambient air are analyzed on the basis of measured air quality data, the location of emissions, meteorological data, and topographic information. A mathematical diffusion model which predicts ambient pollution concentrations from information on emissions and meteorology can be used in areas where irregular topographical features would not invalidate the theoretical model. As a whole, the technical study indicates how large the air quality control region must be in order to encompass most pollution sources and most people and property affected by those sources.

The study of urban factors encompasses a different set of considerations. It reviews existing governmental jurisdictions, the location of urban and industrial concentrations, expected patterns of urban growth, cooperative regional arrangements, existing State and local air pollution control programs, and other associated factors. As a whole, the study of urban factors is

designed to indicate how large a region must be in order to encompass expected regional growth and to encourage cooperation among political units in controlling air pollution.

The body of this report contains a proposal for the boundaries of the Memphis Interstate Air Quality Control Region and outlines the evaluation of technical and urban factors which was the basis of the proposal. The report is intended to serve as the background document for the consultation with appropriate State and local authorities.

EVALUATION OF URBAN FACTORS

In designing air quality control regions, a number of urban factors need to be considered. Since the geography of a region significantly influences patterns of development, it must be described and its relationship to urban growth examined. As air pollution results primarily from human activity, the location of residences and work-sites is an important factor.

Present and future prospects for industrial development are important, since an air quality control region should be designed for the future as well as the present. Similarly, projection of population growth and distribution must be considered. Political and jurisdictional considerations are important since the success of an air quality control region depends on the cooperative efforts of different political jurisdictions.

The following discussion presents these considerations for the Memphis interstate area.

GEOGRAPHY OF THE REGION

The geography of a region can significantly influence both the direction and scale of development of its urban center.

The City of Memphis is located in Shelby County on the east bank of the Mississippi River at the extreme southwestern corner of the State of Tennessee. It sits on bluffs which rise some seventy feet above the River which at Memphis is about 200 feet

above sea level. The terrain east of the city is relatively flat with elevations of not more than 300-350 feet above sea level. Tipton County, Tennessee, to the north, and DeSoto County, Mississippi, to the south, also have a gently rolling terrain of similar elevations. Only at distances of about twenty miles northeast and east of the city does the terrain rise as high as 400 feet above sea level. Three drainage basins in Shelby County -- those of the Loosahatchie and Wolf Rivers in the northern portion of the county and Nonconnah Creek in the south -- proceed generally westward toward the Mississippi River.

West of Memphis and on the west bank of the Mississippi River is Crittenden County, Arkansas. Its terrain, unlike the bluff formation on the River's eastern bank, is a flat, alluvial expanse, virtually at River level and requiring extensive dikes and drainage systems to keep the River at bay. This flood plain topography continues north, west and south of Crittenden.

The dominant characteristics of the region's topography -- the low-lying flat flood plain on the west, the gently rolling higher ground on the east, and the drainage basins of the eastern area -- have influenced the direction of urban and industrial growth. To date, the formidable barrier of the Mississippi River (with only one highway bridge across it) and the flood plain beyond it have discouraged urban development west of Memphis in a period of vigorous expansion to the east and south. This expansion has been

largely channeled and contained by Shelby County's major drainage basins.

The scale of urban development in Memphis is, of course, dependent on a complex of economic factors, but the city's physical location is one such factor.

Memphis has unique locational advantages. It is a major mid-continent transportation center. Its position inland on the Nation's greatest navigable river has attracted railroads, highways, and air facilities as well as port facilities and barge lines. Since the city is on the natural path between the Texas and Louisiana natural gas fields and major consuming centers in the Great Lakes and northeastern areas of the country, an array of major gas pipeline systems pass nearby.

Its transportation facilities, combined with the advantage of a central location in the heart of a highly productive cotton growing area, made Memphis once the country's leading inland cotton market, just as its location next to hardwood forests made it the leading hardwood lumber center of the world. More recently, the availability of natural gas has attracted chemical industries to the city.

Today, the Memphis Metropolitan Area is the largest between St. Louis and New Orleans and between Dallas and Atlanta. Within this area, Memphis is at present more closely linked to the economies of Mississippi, Arkansas, Tennessee, and Southeast Missouri than

to other states in the Mid-South or to the Nation as a whole. The extent to which this locationally determined economic relationship, combined with other factors, will continue to affect the growth of Memphis is examined in the sections which follow.

PRESENT POPULATION AND INDUSTRIAL PATTERN OF REGION

A thirteen-county area surrounding Memphis had a population of 1,084,000 in 1966, the most recent year for which comparable Census Bureau population estimates for counties are available. This area includes the three counties which make up the Mississippi-Arkansas-Tennessee Council of Governments (MATCOG) - Shelby (Tennessee), Crittenden (Arkansas), and DeSoto (Mississippi), and the ten counties adjoining (See Table I). Shelby County accounted for roughly two-thirds of the total population, while one-third was distributed among the remaining twelve counties.

Considered in relation to county area, the population of the thirteen counties shows a high density in Shelby County to low or very low densities in all the others (See Figure 3). This low density pattern results from high proportions of county acreage devoted to farming and from rapid consolidation of small farm units into larger commercial farms requiring less labor. The last agricultural census (1964) showed that even in Shelby County more than half of the county's area was farmland. In neighboring Crittenden and DeSoto Counties, for example, farm acreage constituted about ninety percent of the total.

TABLE I

Population of Memphis Area Counties, 1966

State and County	Number (thousands)
Tennessee:	
Shelby	697.1
Fayette	24.3
Tipton	30.9
Arkansas:	
Crittenden	51.9
Cross	20.7
Lee	23.9
Mississippi	76.3
Poinsett	29.9
St. Francis	34.7
Mississippi:	
DeSoto	31.3
Marshall	24.7
Tate	19.8
Tunica	18.2
Total	1,083.7

Source: U. S. Department of Commerce, Estimates of the Population of Counties and Metropolitan Areas, July 1, 1966, Current Population Reports, Series P-25, No.427.

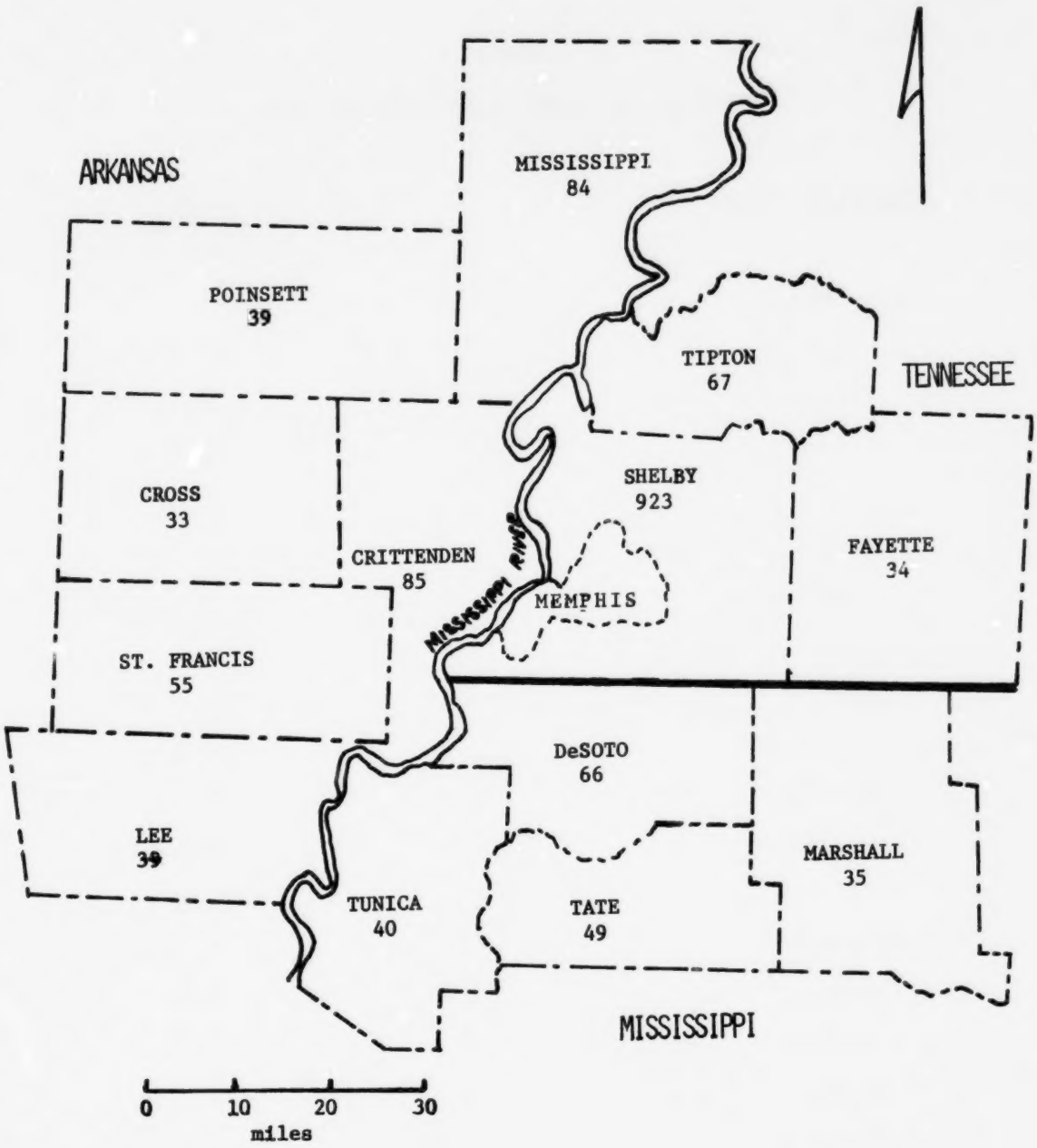


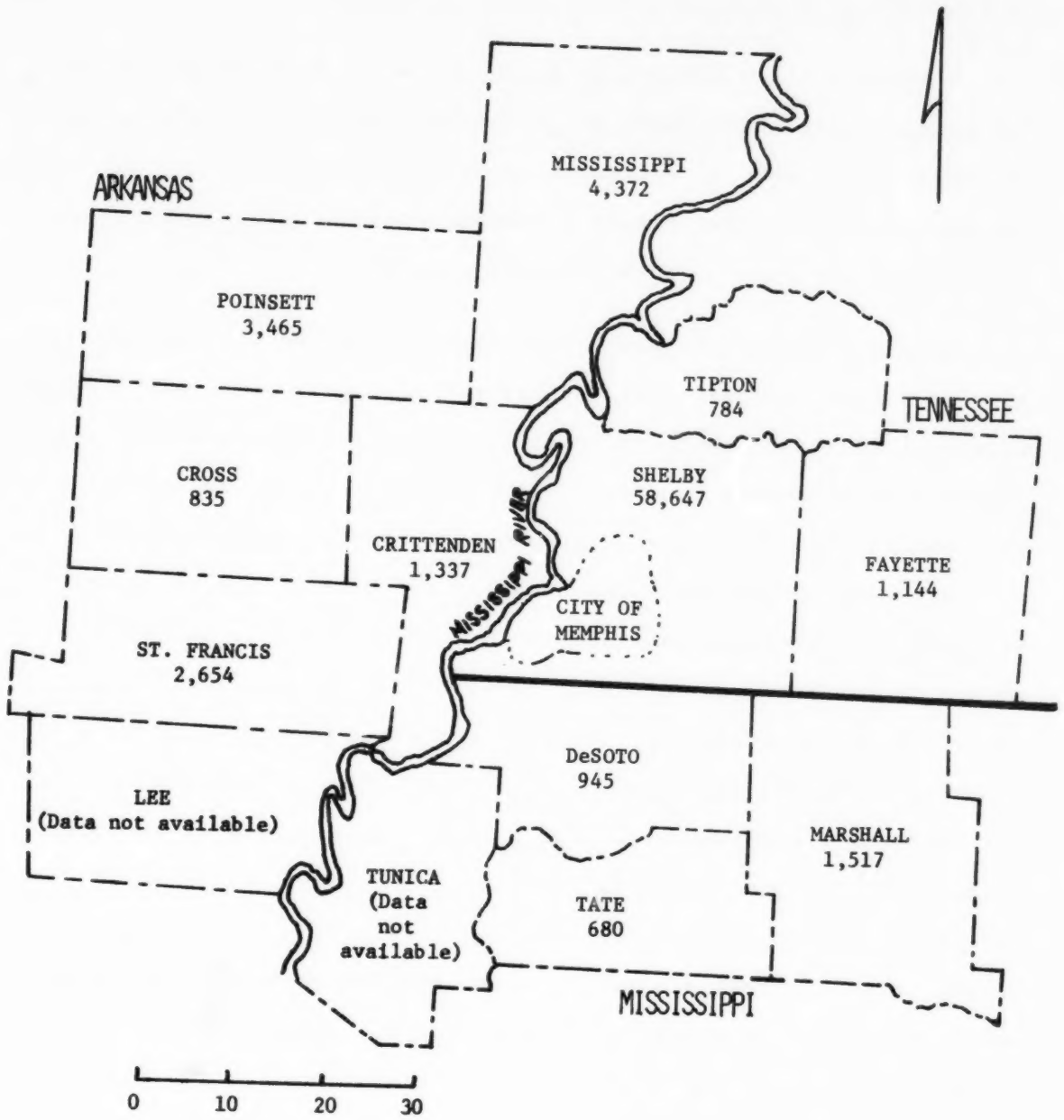
FIGURE 3 - Population Per Square Mile in Memphis Study Area By Counties, 1966

Within Shelby County, the City of Memphis itself has an average density of about 3,000 persons per square mile, with an area of dense concentration of over 10,000 persons per square mile near the western edge of the city, a "C" shaped area in the center with densities of 5,000 to 10,000 persons per square mile, and areas of lower densities, encircling the first two and extending to the present city limits. (See Figure 4)

Industrial activities in the Memphis area counties, as measured by manufacturing employment in 1967, show a locational pattern similar to that of the area's population except that the degree of concentration in Shelby County is somewhat greater. Shelby had 58,647 factory employees in 1967 -- more than three-fourths of the area total of 76,420 (See Figure 5).

Both population and industrial location data appear to show Shelby County as the primary center of urban concentration. However, development due to the westward and southward movement of population and industry out of Memphis is spreading into Crittenden and DeSoto counties. The Southhaven area on the northernmost edge of DeSoto County is actually an extension of Memphis, and West Memphis in Crittenden County owes much of its growth to its large neighbor across the Mississippi River. Thus, the present contiguous area of population and industrial concentration crosses the borders of three counties -- Shelby, Crittenden, and DeSoto -- and three States -- Tennessee, Arkansas, and Mississippi.

FIGURE 4 - Memphis Population Density, 1966



(Total number of manufacturing employees in 13-county area: 76,420)

FIGURE 5 - Number of Manufacturing Employees in Memphis Area Counties, 1967

PROBABLE SCALE OF POPULATION AND ECONOMIC GROWTH

A Memphis State University study estimates 1970 population of the three-county MATCOG area to be 910,200 and projects 1990 population at 1,452,400, an estimated increase of 59.6 percent. 1/ The estimated increase implies a compound rate of growth of about 2.4 percent per year over the 20-year period.

This was an actual growth rate achieved by the area in the 1950-60 decade, largely because Shelby County grew vigorously enough to offset sluggish growth in Crittenden County and an absolute population loss in DeSoto County. However, more recently in the six-year period 1960-66, the area growth rate slowed to 1.9 percent per year even though there was a marked reversal of the no-growth situation in Crittenden and DeSoto (See Table II). If the more recent trend continues between 1970 and 1990, the projected population of the area would be roughly 46 percent greater than in 1970, or about 1,329,000 instead of the 1,452,400 figure projected on the basis of 2.4 percent per year growth. If the rate of increase in the MATCOG region falls to the 1.4 percent per year level of the States of Tennessee, Arkansas, and Mississippi, as well as that of the United States as a whole in the 1960-66 period, MATCOG 1990 population would be about 1,202,000. The 1.4 percent growth rate falls between the "high" and "low" population growth rates projected by the U.S. Bureau of the Census for the Memphis Metropolitan

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1/ Comprehensive Plan Report, Population and Economic Base of the Mississippi-Arkansas-Tennessee Council of Governments Area, June 1969.

TABLE II

Population Changes and Growth Rates, MATCOG Counties, Tri-State Area, and The United States 1950 - 1960 and 1960 - 1966

	Percent change in population		Annual percentage rate of growth	
	1950 - 1960	1960 - 1966	1950 - 1960	1960 - 1966
Shelby County	30.0	11.2	2.7	1.7
Crittenden County	0.8	9.1	0.1	1.4
De Soto County	- 2.9	30.9	- 0.3	4.4
MATCOG area	26.0	11.6	2.4	1.9
State Of Tennessee	8.4	8.7	0.8	1.3
State of Arkansas	- 6.5	9.9	- 0.7	1.5
State of Mississippi	0	7.4	0	1.1
Tri-State area	2.1	8.6	0.2	1.4
United States	18.5	9.3	1.7	1.4

Source: Computations based on data from publications of U.S. Department of Commerce, Bureau of Census

Area (including Shelby and Crittenden Counties) for the period 1960-75. 2/

Since population increases for particular areas normally reflect in-migration in response to economic opportunities, as well as natural increase, a high rate of population increase is more likely if economic activity in the area is vigorous and, particularly, if that activity is in growth sectors of the National economy.

According to U.S. Department of Commerce estimates, recent growth of personal income in the Memphis Metropolitan Area (Shelby and Crittenden Counties), is well above the average for all urban areas, both on an overall and on a per capita basis (See Table III). The Memphis area's overall growth of 75 percent in the eight years, 1959-67, is at a rate which would result in doubling of the size of the economy in ten years and quadrupling in 20 years. But, since this very high economic growth rate was achieved in the face of a decline in the population growth rate, compared to the 1950-60 decade, its continuation will not necessarily mean a population surge in the future.

The Memphis area is more dependent for its income on local market demand than are metropolitan areas as a whole in the United States. Service activities income -- government; transportation, communication, and public utilities; contract construction; wholesale and retail trade; finance, insurance, and real estate; and

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2/ U.S. Department of Commerce, Population Estimates, Current Population Reports, Series P-25, No. 415, January 31, 1969.

TABLE III

Growth in Personal Income and Per Capita Personal Income
Memphis Metropolitan Area* Compared to
All Metropolitan Areas, 1959 - 67

	Personal income			Per capita personal income		
	1959	1967	Percent increase 1959-67	1959	1967	Percent increase 1959-67
	(millions of dollars)			(dollars)		
Memphis Metropolitan area*	1,202	2,104	75.0	1,788	2,737	53.0
All Metropolitan areas	290,062	473,246	63.2	2,448	3,511	43.0

* Shelby County, Tennessee, and Crittenden County, Arkansas.

Source: U.S. Department of Commerce, "Metropolitan Area Income in 1967", Survey of Current Business, May 1969, pp. 19-33.

services as such -- are largely dependent on local market demand. Income from manufacturing is usually much less dependent on local demand. In 1967, the Memphis Metropolitan Area's relative income from service activities was 62.4 percent, compared to 54.9 percent in all metropolitan areas. At the same time, Memphis derived only 18.5 percent of its income from manufacturing, compared to an average for all cities of 24.8 percent (See Table IV). This 1967 pattern of Memphis Metropolitan Area income is essentially that of the area's 1959 income pattern, despite the 75 percent growth in the intervening period.

The lack of fundamental change in the Memphis area economy is further confirmed by employment figures for 1959 and 1969. In 1969, manufacturing employment constituted exactly the same proportion of all non-agricultural employment as in 1959, namely, 23.1 percent. While the proportions employed in wholesale and retail trade and transportation and public utilities declined between 1959 and 1969, other service activities employment rose correspondingly so that the total share of all service activities was the same in both years (See Table V).

Even in manufacturing, a large share of recent employment in the Memphis area is in industries which mainly serve local market rather than National market demands (See Table VI). For example, the chemicals industry provides agricultural chemicals and the non-electrical machinery industry produces agricultural machinery principally for farms in the area.

TABLE IV

Sources of Personal Income, Memphis Metropolitan Area Compared with All Metropolitan Areas of the United States, 1967

	Memphis (Percent of total personal income)	All Metropolitan Areas (Percent of total personal income)
Total personal income	100.0	100.0
Property income and transfer payments, less personal contributions for social insurance	17.3	18.8
Total earnings	82.7	81.2
Farm earnings	1.6	.8
Total nonfarm earnings	81.1	80.4
Government earnings	14.3	12.7
Total Federal	7.7	5.7
Federal civilian	4.5	3.6
Military	3.2	2.1
State and local	6.6	7.0
Private nonfarm earnings	66.8	67.7
Manufacturing	18.5	24.8
Mining	.1	.5
Contract construction	5.4	5.0
Transportation, communication, and public utilities	7.2	6.1
Wholesale and retail trade	18.7	14.1
Finance, insurance and real estate	4.2	4.8
Services	12.6	12.2
Other	.1	.2

Source: Unpublished analysis obtained from the U.S. Department of Commerce.

TABLE V

Non-Agricultural Employment in Memphis Metropolitan Area, 1959 and 1969

	Number of Employees (Thousands)		Percent of All Non-Agricultural Employees	
	1959	July 1969	1959	July 1969
All non-agricultural establishments	186.5	268.4	100.0	100.0
Mining	.3	.2	--	--
Contract construction	10.4	14.7	5.6	5.5
Manufacturing	43.0	61.9	23.1	23.1
Transportation and public utilities	16.0	20.2	8.6	7.5
Wholesale and retail trade	50.9	67.6	27.3	25.2
Finance, insurance, and real estate	9.4	14.1	5.0	5.3
Services and miscellaneous	25.7	43.9	13.8	16.4
Government	30.8	45.8	16.5	17.1

Sources: U.S. Department of Labor, Monthly Labor Review, 1969 Statistical Supplement and issue of September 1969.

TABLE VI

Employment in Major Manufacturing Industries
Shelby County, Tennessee, 1967

	Number of Employees as of March, 1967	
	Number	Percent of All Manufacturing
All Manufacturing	58,647	100.0
Food and kindred products	8,619	14.7
Electrical machinery	6,982	11.9
Lumber and wood products	5,105	8.7
Furniture and fixtures	3,206	5.5
Paper and allied products	3,644	6.2
Apparel and related products	3,090	5.3
Transportation equipment	1,325	2.3
National or regional categories	31,971	54.5
Chemicals and allied products	5,464	9.3
Fabricated metal products	2,419	4.1
Primary metal industries	1,013	1.7
Printing and publishing	1,452	2.5
Petroleum and coal products	392	.7
Stone, clay and glass products	770	1.3
Non-electrical machinery	4,621	7.9
Mainly regional categories	16,131	27.5
All other *	10,545	18.0

Source: U.S. Department of Commerce, Bureau of the Census, County Business Patterns, 1967.

* Includes some major industry groups on which details were not published to avoid disclosure of information on particular firms.

Thus, currently, as in 1959, and very probably in the future, the Memphis area economy is that of a regional center being restrained or boosted primarily by the region it serves rather than by the National economy as a whole.

In the 1959-67 period, strong economic growth in the States of Tennessee, Mississippi, and Arkansas, well above that of the United States as a whole, sustained exceptional growth in the Memphis Metropolitan Area (See Table VII). However, the growth of the three mainly rural states has been dependent on the prosperity of local agriculture to a high degree. Since the importance of agriculture is declining nationwide, the Memphis area cannot count on this source alone for major sustained growth. As a counterbalance, of course, Memphis may be able in a systematic way to expand more rapidly into industries of National scope, using its exceptional transportation advantages as an offset to the closer physical distance of competing metropolitan industrial areas to major markets.

For this type of industrialization, a skilled or highly trainable labor force is a valuable asset. The Memphis area has a disadvantage in this respect because, outside of Shelby County, the wider 12-county area from which labor supply could be drawn has had extremely low educational levels. According to 1960 Census data, the proportion of adults (25 years old and over) who had completed less than five years of school ranged from 23 percent in one county to as high as 48 percent in another.

There are grounds, therefore, for projecting future growth in the MATCOG tri-county area at a rate below recent levels. Assuming

TABLE VII

Growth in Personal Income in
Tennessee, Mississippi, and Arkansas
1959 to 1967

State	Percent Increase 1959-67	Annual Percentage Rate of Growth 1959-67
Memphis Metropolitan Area*	75.0	7.2
Tennessee	72.2	7.0
Mississippi	73.1	7.1
Arkansas	70.8	6.9
Tri-State Area	72.1	7.0
U.S. Total	64.1	6.4

Source: U.S. Department of Commerce,
Survey of Current Business,
August 1968.

*Shelby County, Tennessee, and Crittenden County, Arkansas.

that population in the MATCOG tri-county area increases by 1990 to a total of 1,202,000, with an age distribution of population and proportionate size of labor force like that of 1967, and a rate of unemployment no higher than four percent, total employment of around 429,400 would be required. With no change in the relative distribution between manufacturing and other activities, manufacturing employment would total 85,900, an expansion of about 41 percent over 1967.

PROBABLE DIRECTIONS OF PHYSICAL GROWTH

Both current locational trends and deliberate cooperative planning by MATCOG will influence the physical growth of the Memphis area as population and economic activity expand.

To date, urban development in the MATCOG region has been described as "contained sprawl," centered in the City of Memphis with growth into Crittenden County to the west and northern DeSoto County to the south. In Shelby County, growth has occurred along major transportation routes. 3/

Of the wealth of transportation arteries in the area now, highways are expected to exercise a dominant influence. The completion of a second major interstate system highway (I-40) bridge across the Mississippi should stimulate a welcome development of the West Memphis area of Crittenden County. Generally, however, it is feared

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3/ Mississippi-Arkansas-Tennessee Council of Governments, Land Use and Transportation Plan, March 20, 1968.

that future growth dictated by the arterial highway pattern alone would result in uneconomic ribbon development. Industrial plants could lead the way as the costs of distance from the central city became less than the costs of operation in areas of high or growing congestion. To direct physical development into a more economic pattern, MATCOG plans the establishment of a number of industrial and residential centers, served and confined by beltway rings intersecting the major arterial highways (See Figure 6).

The planned expansion of the metropolitan area by 1990 is shown in Figure 7. In addition to an expansion of the present contiguous area of the City of Memphis farther eastward into Shelby County and southward into DeSoto County, urban growth is planned in West Memphis and in the satellite centers of Millington, Arlington, and Collierville. The bulk of industrial activity is expected to remain well within the expanded Memphis and West Memphis area, and all urban development confined to the three-county MATCOG region.

REGIONAL GOVERNMENTAL ORGANIZATION

The Memphis Region includes parts of three States: Tennessee Mississippi and Arkansas.

The central city of the Region is Memphis, Tennessee, the county seat of Shelby County. A number of Federal agencies and a United States District Court are located in Memphis, along with offices of the State of Tennessee. The Corps of Engineers maintains a District Office in Memphis, which administers a large section of the Mississippi River.

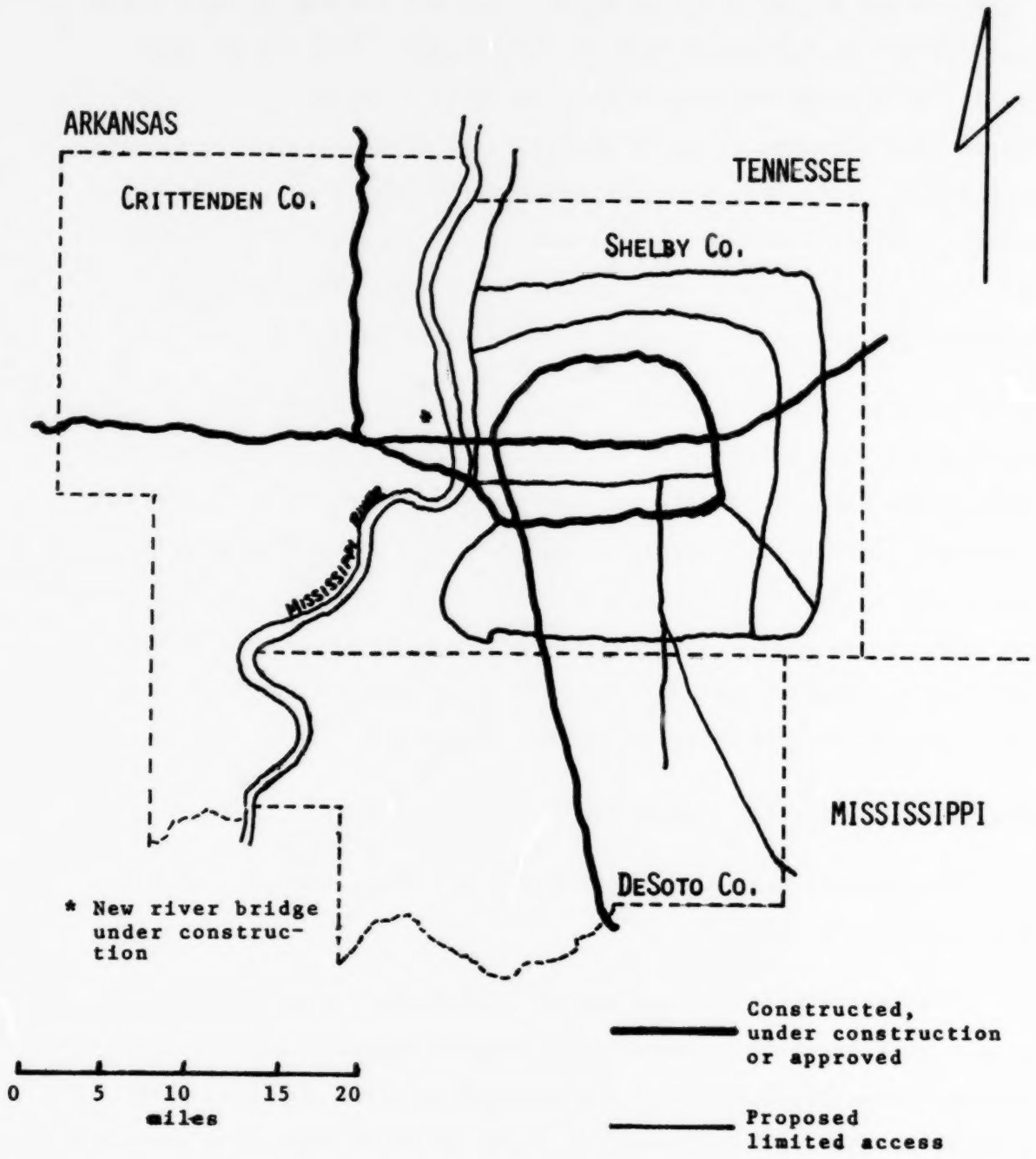
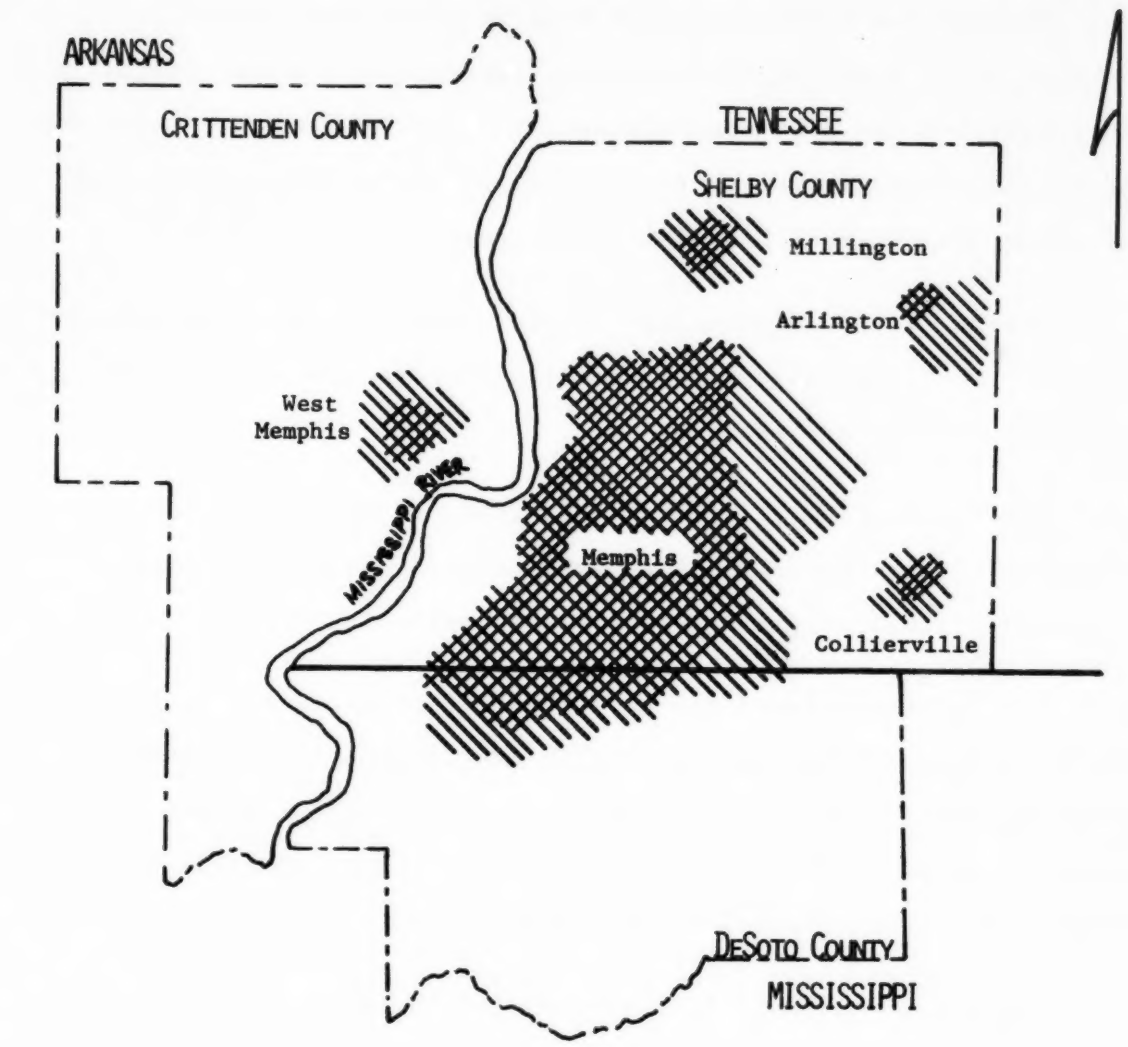


FIGURE 6 - Interstate and Limited Access Highway System



Source: Mississippi-Arkansas-Tennessee Council of Governments, Comprehensive Plan Report, Population & Economic Base, June 1969.

FIGURE 7 - The Planned Expansion of the Memphis Metropolitan Area by 1990

Memphis has a Mayor-Council form of government, recently adopted after a period of Commission government. Shelby County is governed by a Board of Commissioners and a County Court. There are five other incorporated municipalities in Shelby County, only one of which (Millington) has over 5,000 people.

DeSoto County, Mississippi, is governed by a Board of Supervisors. The only incorporated municipality in DeSoto County is Hernando, the county seat.

Crittenden County, Arkansas, is governed by a County Court. The City of West Memphis has a Mayor-Council government. The Crittenden county seat is Marion (1960 population 881).

Two important functions have been consolidated in Memphis-Shelby County: planning and health. The Memphis-Shelby County Planning Commission was established in 1956 by joint action of the two governments. The Health Department is also consolidated as the Memphis-Shelby County Health Department.

The county and municipal governments in the three-county Region participate in the Mississippi-Arkansas-Tennessee Council of Governments (MATCOG), an agency which coordinates planning and other intergovernmental activities in the Region. MATCOG was informally organized in 1967 and was formally incorporated in June 1968. The chief elected officals of all the governments in the Region constitute the membership of MATCOG region, including a comprehensive land use plan, a public facilities plan, and, together

with State Highway Departments, a Memphis Urban Area Transportation Study. At the moment, staff assistance for MATCOG is drawn from the Memphis-Shelby County Planning Commission. The 314(b) Comprehensive Health Planning Agency is the Mid-South Medical Center Council, which also coordinates the Regional Medical Program for a 69 county five state region. MMCC cooperates with MATCOG and the Memphis-Shelby County Health Department for health planning purposes in the Region.

EXISTING AIR POLLUTION CONTROL ACTIVITIES

Air pollution control activities in the Region are conducted by State agencies in Tennessee, Mississippi and Arkansas, and by the Memphis-Shelby County Health Department.

The Tennessee Air Pollution Control Board is responsible for air pollution control in the State of Tennessee. This Board, established in 1967, consists of ten members, two of whom hold office ex officio, and eight of whom are appointed by the Govenor. The Board has general authority to adopt rules and regulations necessary for the implementation of air pollution control within the State. During 1969 the Board adopted ambient air quality standards which establish limits upon settleable particulates, suspended particulates, soiling index, sulfur oxides measured by the West-Gaeke method, sulfur oxides measured by the lead sulfation method, and florides. For each pollutant the standards define four separate limits which correspond to four types of land use; industrial, commercial, residential, and recreational. The limits for industrial areas are the least stringent, and for

recreational areas the most stringent. The Board has also adopted various regulations to control the emission of particulates into the ambient air. Open burning is prohibited, with certain exceptions. Visible emissions from stacks are limited to Ringlemann number 2 for existing plants and Ringlemann number 1 for new plants. Particulate emissions from incinerators, fuel burning, and industrial processes are also limited by additional regulations. The Division of Air Pollution Control in the State Department of Public Health is responsible for implementing rules and regulations adopted by the Board. The budget for the Division jumped from about $50,000 last year to about $250,000 this year.

The City of Memphis and Shelby County operate a joint air pollution control program, under authority specifically granted by the State legislature in 1969. The City and County have adopted joint emission regulations, and authorized the Memphis-Shelby County Health Department to enforce the regulations. The regulations restrict smoke emissions, open burning, incinerator burning, fly ash, and particulate emissions. They set limits upon permissible sulfur dioxide concentrations near sources. Furthermore, they provide emergency authority applicable during serious air pollution episodes, and allow the granting of variances. The budget of the Memphis-Shelby County Health Department for air pollution control is $115,000.

The Mississippi Air and Water Pollution Control Commission conducts the air pollution control program for the State of Mississippi. The

Commission was established in 1966, and has ten members. Although the Commission has not yet adopted air quality standards or emission regulations, at the present time it is considering regulations which would restrict the emissions of particulates and smoke, and control incineration and open burning. The Budget of the Mississippi program increased from $37,000 last year to $67,000 this year. The State statutes do not prohibit the establishment of local programs, but none has been initiated in portions of Mississippi adjacent to Memphis.

The Arkansas Pollution Control Commission conducts the air pollution, water pollution, and solid waste disposal program for the State of Arkansas. The Commission, composed of 8 members, has exclusive statewide jurisdiction over air pollution control, so that no local programs are allowed.

The Commission was established in 1965, and now has a budget of about $92,000. Regulations adopted by the Commission provide for a permit system. Permits are issued when no violation of the statewide emission regulation will occur. The emission regulations govern smoke and particulate emissions and restrict open burning. They also control emissions from fuel burning and from motor vehicles.

EVALUATION OF TECHNICAL FACTORS

The technical factors essential for consideration in the establishment of an air quality control region are: the total quantity of major pollutants emitted to the air by sources in the area, the geographic pattern of such emissions, and the typical patterns of dispersion of pollutants following emissions.

The Emissions Inventory

In the Memphis area, the amount of pollutant emissions, the type of source, and the geographic pattern of emissions were determined by an emissions inventory. The inventory estimated emissions for the year 1967, and covered pollution sources of Shelby, Crittenden, and DeSoto Counties. Pollution sources in areas adjoining these counties were not included in the inventory since they were considered to be insignificant. Data were obtained for five major pollutants; only sulfuf oxides and particulates are discussed in this analysis. A more complete tabulation of emissions is available in the emission inventory propared by NAPCA for this Region.

The quantity of these pollutants emitted in the Memphis area was estimated individually for major "point" sources and area-wide for all other sources by use of a survey technique developed by the Pulbic Health Service. 4/ The major point sources in the Memphis

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4/ Public Health Service, Rapid Survey Technique for Estimating Community Air Pollution Emissions. Publication No. 999-AP-29, Environmental Health Series, U.S. DHEW, Division of Air Pollution, Cincinnati, Ohio, October 1966.

area included the power plant, large industrial plants, airports, and central refuse burning facilities. Area sources included vehicles, space heating, smaller industrial plants, and on-site refuse burning.

Emission estimates for the year 1967 were generally derived by applying average emission factors 5/ to indicators of pollutant emissions such as fuel type, fuel consumption rates, refuse burning rates, and appropriate production data. Because the emission factors are averages, estimates derived in this way for a particular source will vary from its actual emissions to the extent that its equipment, operating rate, operating efficiency and similar characteristics diverge from the average. Estimates for a large number of sources are less likely to differ from actual emissions since their characteristics as a group can be expected to be like those used to determine average emission factors.

By combining the emission estimates for the major point sources and for area-wide sources, the total quantities in tons per year of each pollutant was estimated. Tables VIII and IX analyze these totals for 1967 by the amounts and percentage shares of each principal category of pollution source. Table IX shows that in the Memphis area, the power plant accounted for 70 percent of all sulfur oxide emissions. A variety of sources share significantly in particulate emissions, but the power plant alone accounted for 44 percent of the total.

5/ Public Health Service, Compilation of Air Pollutant Emission Factors. Publication No. 999-AP-42, Environment Health Series, U.S. DHEW, National Center for Air Pollution Control, Durham, North Carolina.

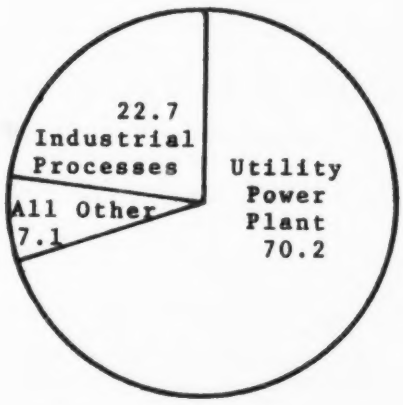
TABLE VIII

Summary of Air Pollutant Emissions in Memphis 1967 (Tns/Yr)

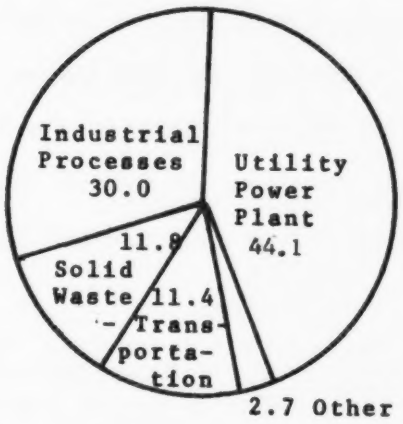
Source Category	Sulfur Oxides	Particulates
Fuel Combustion in Stationary Sources		
Industry	3,500	600
Steam-Electric	54,500	15,000
Residential	N	200
Commercial & Institutional	N	100
SUB-TOTAL	58,000	15,900
Transportation		
Road Vehicles	1,600	2,700
Other	300	1,200
SUB-TOTAL	1,900	3,900
Solid Waste Disposal		
Incineration	N	1,900
Open Burning	100	2,100
SUB-TOTAL	100	4,000
Industrial Processes	17,600	10,200
Total All Sources	77,600	34,000

N-negligible

TABLE IX



SULFUR OXIDES
(1967 total, 77,600 tons)



PARTICULATES
(1967 total, 34,000 tons)

The geographic pattern of these emissions was determined by distributing emissions among grid zones as shown in Figure 8. Estimated emissions of major point sources were attributed to the grids of their location. (See Table X and Figure 9). Areawide totals of emissions from other sources were allocated to grids in accordance with information on the general locational distribution of activities causing the pollution.

The resulting emissions estimates for each grid in tons per day of sulfur oxides and particulates in the summer and winter are set forth in Table XI. Figures 10 and 11 show graphically the variations in density of emissions, expressed in tons per day per square mile. It can be seen from the figures that the major pollution sources of the area are heavily concentrated in the City of Memphis and its immediate vicinity.

The power plant, earlier noted as accounting for 70 percent of sulfur oxides emissions on a year-round basis, is shown in Table X as accounting for an even higher proportion in the winter months, when it burns coal rather than natural gas. Figure 9 shows its location in Grid 41. The industrial plant in Grid 17 accounts for 21 percent of total annual emissions of sulfur oxides, at a roughly uniform rate throughout the year. These two major stationary sources produce about 90 percent of all sulfur oxides emissions in the area. They also account for 55 to 60 percent of all annual particulate emissions.

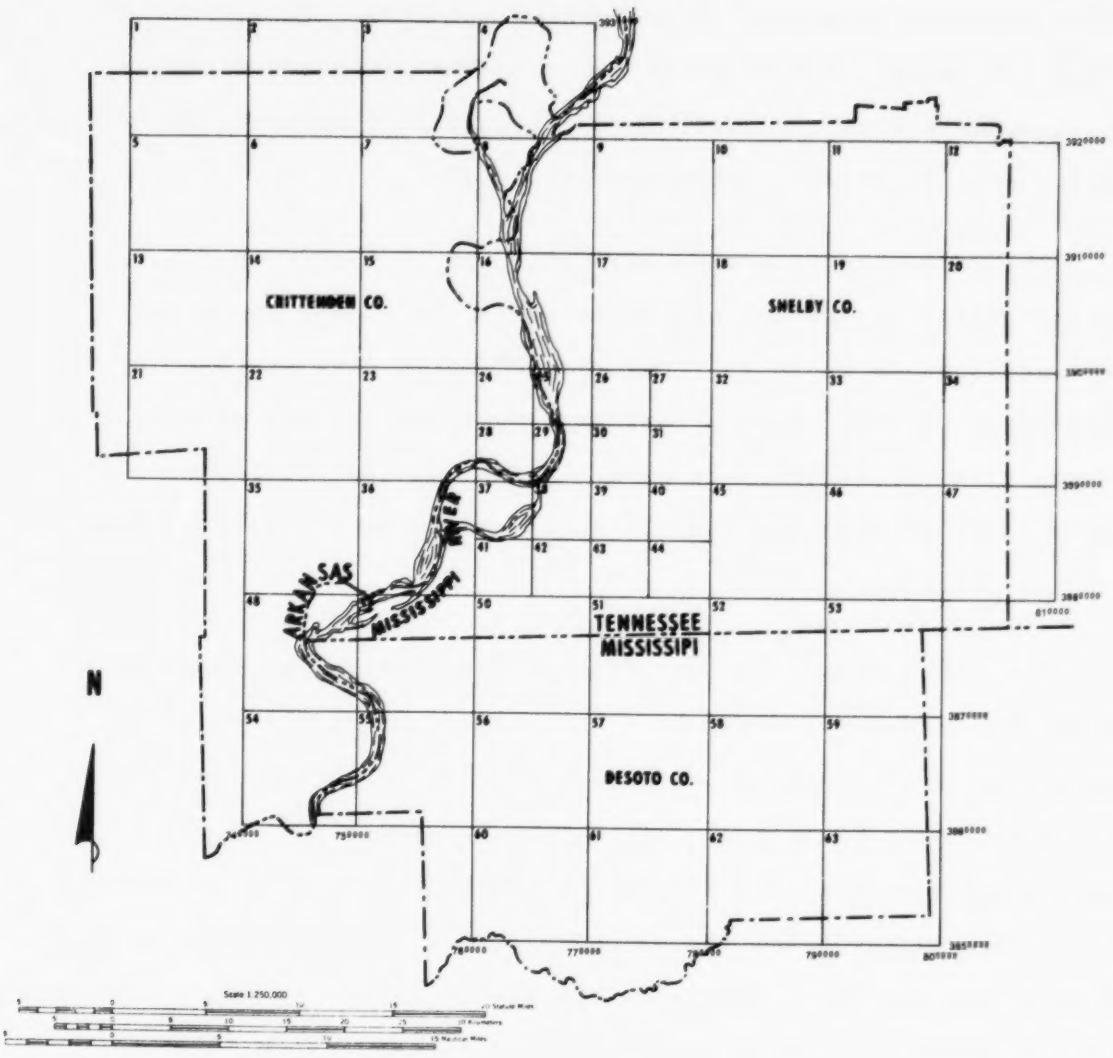


Figure 8. Grid coordinate system for the Memphis study area

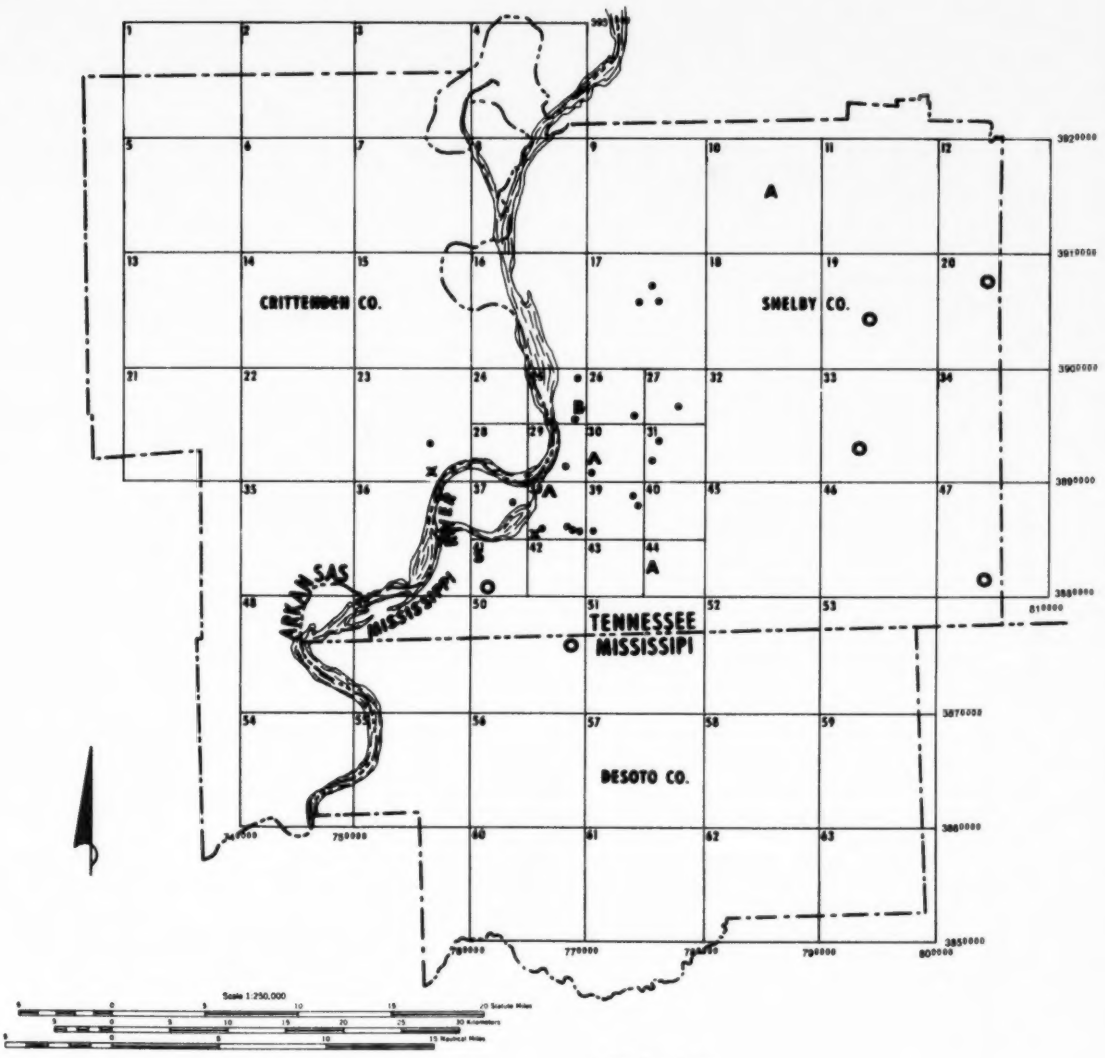
TABLE X

Summary of Point Source Emissions By Season for the Memphis Study Area, 1967 (Tons/Day).

Source Category	Grid	Sulfur Oxides S	Sulfur Oxides W	Particulates S	Particulates W
Airport	10	--	--	0.2	0.2
Industrial	17	--	--	12.5	12.5
Industrial	17	43.5	44.1	0.8	0.9
Industrial	17	0.2	0.5	0.2	0.3
Dump	19	--	--	0.3	0.3
Dump	20	--	--	0.3	0.3
Refinery	23	1.0	1.0	--	--
Industrial	23	--	--	0.1	0.1
Industrial	25	--	--	1.3	1.3
Auto Body Burning	25	--	--	1.4	1.4
Industrial	25	--	--	3.2	3.2
Industrial	26	--	--	--	--
Industrial	26	0.4	0.8	--	--
Industrial	29	--	--	--	--
Incineration	30	--	--	0.2	0.2
Industrial	30	--	--	0.8	0.8
Industrial	31	0.5	1.0	--	--
Industrial	31	0.8	0.8	0.4	0.4
Dump	33	--	--	0.3	0.3
Industrial	37	--	--	1.0	1.0
Industrial	38	--	--	0.2	0.2
Refinery	38	1.3	1.7	--	--
Incineration	38	--	--	0.5	0.5
Industrial	38	--	--	--	--
Industrial	38	2.6	2.6	0.6	0.6
Industrial	38	--	--	1.1	1.1
Industrial	39	--	--	0.3	0.3
Industrial	39	--	--	1.2	1.2
Industrial	39	--	--	0.9	0.9
S. E. Utility	41	30.8	266.6	8.3	72.5
Dump	41	--	--	0.3	0.3
Airport	44	--	--	0.9	0.9
Dump	47	--	--	0.5	0.5
Dump	50	--	--	0.4	0.4
Industrial	53	--	--	0.1	0.1

S-Summer
W-Winter

Source: National Air Pollution Control Administration Emissions Inventory, June 1969



• Industry

O Dump

A Incinerator

A Airport

$ Steam-Electric Utility

x Refinery

B Auto Body Burning

FIGURE 9 - Point Source Locations for Memphis Area.

TABLE XI

Summary of Air Pollutant Emissions from All Sources by Season for Memphis Study Area, 1967 (tons/day)

Grid	Land Area (square miles)	Sulfur Oxides S	Sulfur Oxides W	Particulates S	Particulates W
1	38.6	--	--	--	--
2	38.6	--	--	--	--
3	38.6	--	--	--	--
4	38.6	--	--	--	--
5	38.6	--	--	--	--
6	38.6	--	--	--	--
7	38.6	--	--	0.7	0.7
8	38.6	--	--	--	--
9	38.6	--	--	--	--
10	38.6	--	--	0.3	0.4
11	38.6	--	--	0.2	--
12	38.6	--	--	--	--
13	38.6	--	--	0.4	0.4
14	38.6	--	--	0.5	0.5
15	38.6	--	--	0.1	0.1
16	38.6	--	--	0.1	0.1
17	38.6	43.9	44.7	13.8	13.9
18	38.6	--	--	0.1	0.1
19	38.6	--	--	0.3	0.3
20	38.6	--	--	0.3	0.3
21	38.6	--	--	--	--
22	38.6	--	--	0.2	0.2
23	38.6	1.1	1.0	0.8	0.8
24	9.65	--	--	--	--
25	9.65	0.6	0.6	7.0	7.0
26	9.65	1.0	1.4	1.1	1.1
27	9.65	0.8	0.8	0.8	0.8
28	9.65	0.1	0.1	0.2	0.2
29	9.65	0.7	0.7	1.2	1.2
30	9.65	0.8	0.8	2.2	2.1
31	9.65	2.7	3.1	2.3	2.2
32	38.6	1.0	1.0	1.1	1.1
33	38.6	--	--	0.4	0.4

TABLE XI (Continued)

Grid	Land Area (Square miles)	Sulfur Oxides S	Sulfur Oxides W	Particulates S	Particulates W
34	38.6	--	--	--	--
35	38.6	--	--	0.2	0.2
36	38.6	--	--	0.3	0.3
37	9.65	0.6	0.6	1.3	1.3
38	9.65	5.3	5.7	6.3	6.3
39	9.65	0.7	0.6	3.0	3.0
40	9.65	0.5	0.5	0.8	0.8
41	9.65	30.8	266.6	8.6	72.8
42	9.65	0.6	0.5	1.0	1.0
43	9.65	0.3	0.3	0.2	0.2
44	9.65	0.4	0.4	1.1	1.1
45	38.6	0.5	0.5	0.6	0.6
46	38.6	--	--	--	--
47	38.6	0.1	0.1	0.5	0.5
48	38.6	--	--	0.2	0.2
49	38.6	--	--	0.1	0.1
50	38.6	--	--	0.5	0.5
51	38.6	--	--	0.1	0.1
52	38.6	--	--	0.2	0.2
53	38.6	--	--	0.1	0.1
54	38.6	--	--	0.4	0.4
55	38.6	--	--	0.1	0.1
56	38.6	--	--	0.1	0.1
57	38.6	--	--	0.1	0.1
58	38.6	--	--	0.1	0.1
59	38.6	--	---	0.1	0.1
60	38.6	--	--	0.1	0.1
61	38.6	--	--	0.2	0.2
62	38.6	--	--	0.1	0.1
63	38.6	--	--	0.1	0.1

S - Summer
W - Winter

Source: National Air Pollution Control Administration Emissions Inventory, June 1969.

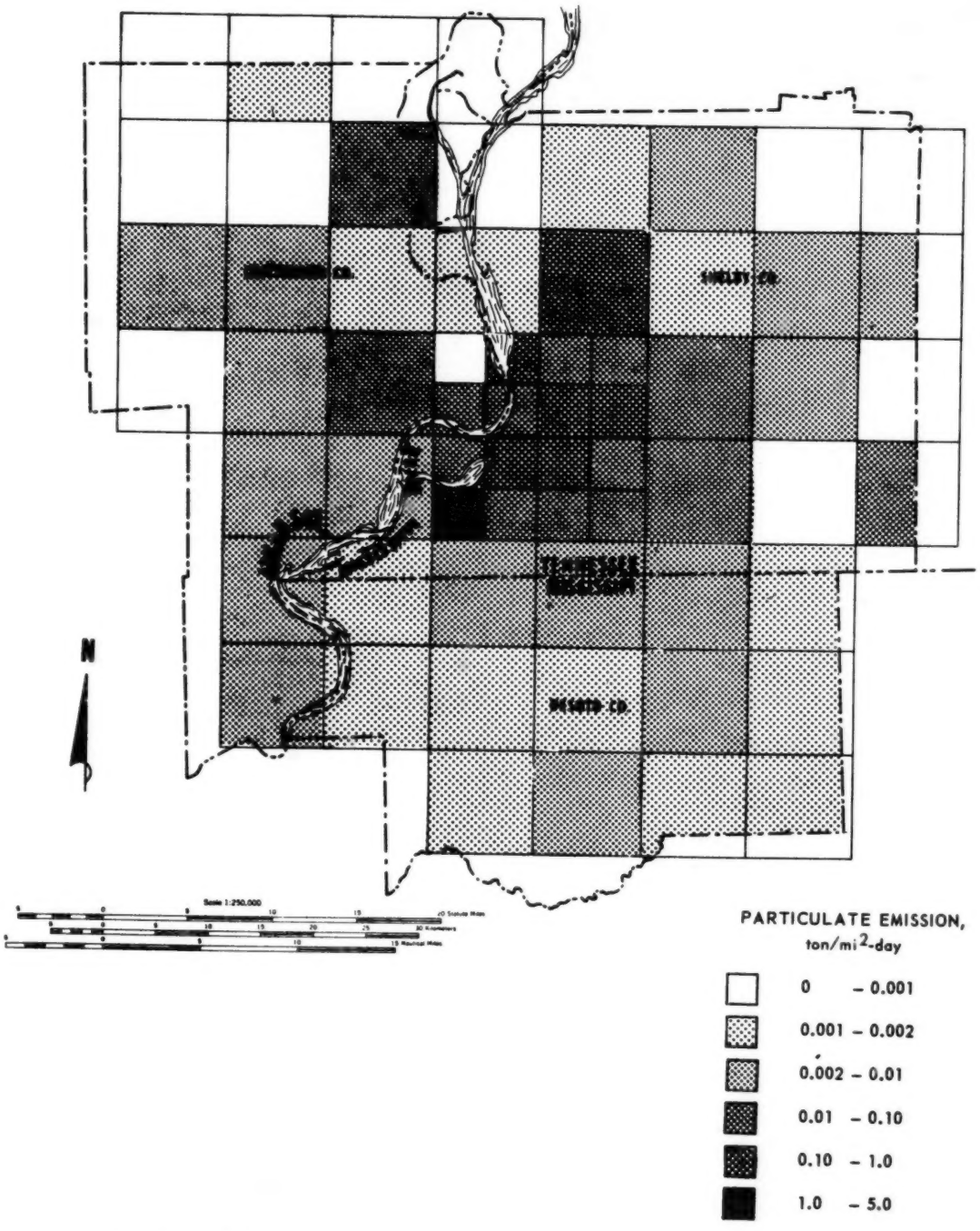


Figure 10 Particulate emission density from all sources for Memphis study area.

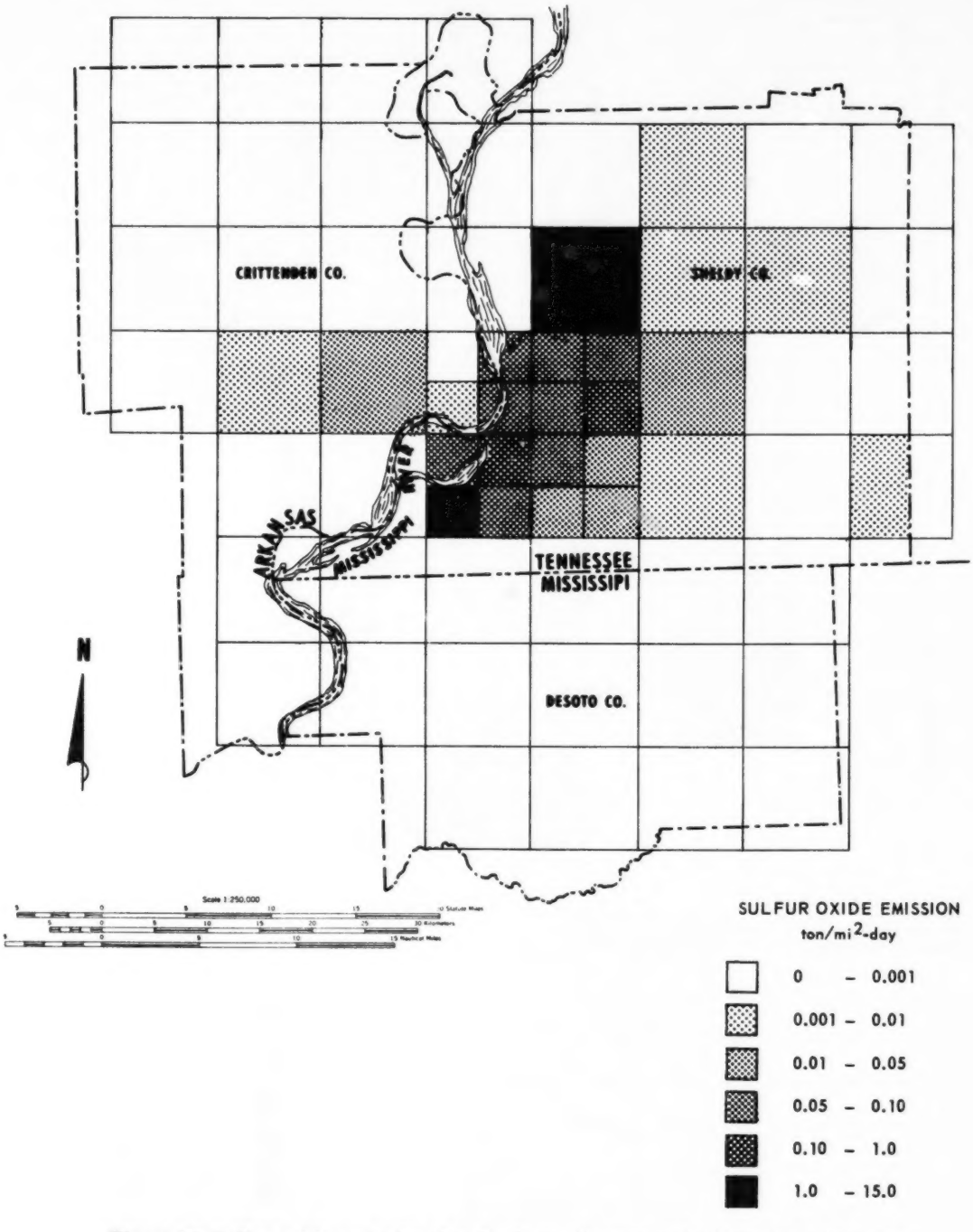


Figure 11 .Sulfur oxide emission density from all sources for Memphis study area.

Expected future growth of population and industry will require expansion of electric power supply in the Region. Whether this expansion is accommodated by additional generating capacity constructed within the Region, or by import from other areas on the TVA Grid will profoundly affect the future amount and distribution of major pollutants in the Region.

The close relationship between the density of emissions and the present degree of urbanization in the Memphis area can be seen by comparing Figures 10 and 11 with the main cross-hatched areas of Figure 7.

Air Quality Analysis

Major considerations for determining the boundaries of an air quality region are that the region must encompass both (1) pollution sources and (2) most people and property affected by the source emissions. Locations of emission sources are determined in the emission inventory. The inventory, however, does not provide insight into the people and property affected. Therefore, the regional boundary cannot be adequately determined from the emission data alone.

Ideally, the effect on people and property could be studied by review of adequate air quality data, measured over sufficient time and at enough points to be reliable. Few areas in the United States have as yet developed this information in enough detail to satisfy the requirements of the study. The Memphis region is similar to most regions in not having developed air sampling networks

which could be relied on as guides to establishing regional boundaries.

As an alternative, therefore, a meteorological diffusion model is used to compute theoretical pollutant concentrations in the ambient air at specified receptor points. The model is based on a mathematical treatment of pollutant emissions and meteorological data. While there are inherent limitations in the model, it can be used to predict reasonable spatial distributions of long-term (seasonal and annual rather than episodic) average pollutant concentrations. In the Memphis area, the model was used to predict sulfur oxides and particulate concentrations in the ambient air at various receptor locations throughout the area.

It should be noted that the concentration contours resulting from the diffusion model are theoretical in nature and are not intended to show absolute ambient air quality. The contours show relative levels and are only a guide for determining areas affected by inventoried emissions.

Figure 12 has been produced using inventoried emissions from the study area. It shows theoretical distributions of sulfur oxides in winter and summer and the distribution of particulates on the same basis.

Note that the highest sulfur oxide concentrations in the winter are along the river south of Memphis, but shift northeasterly in the summer

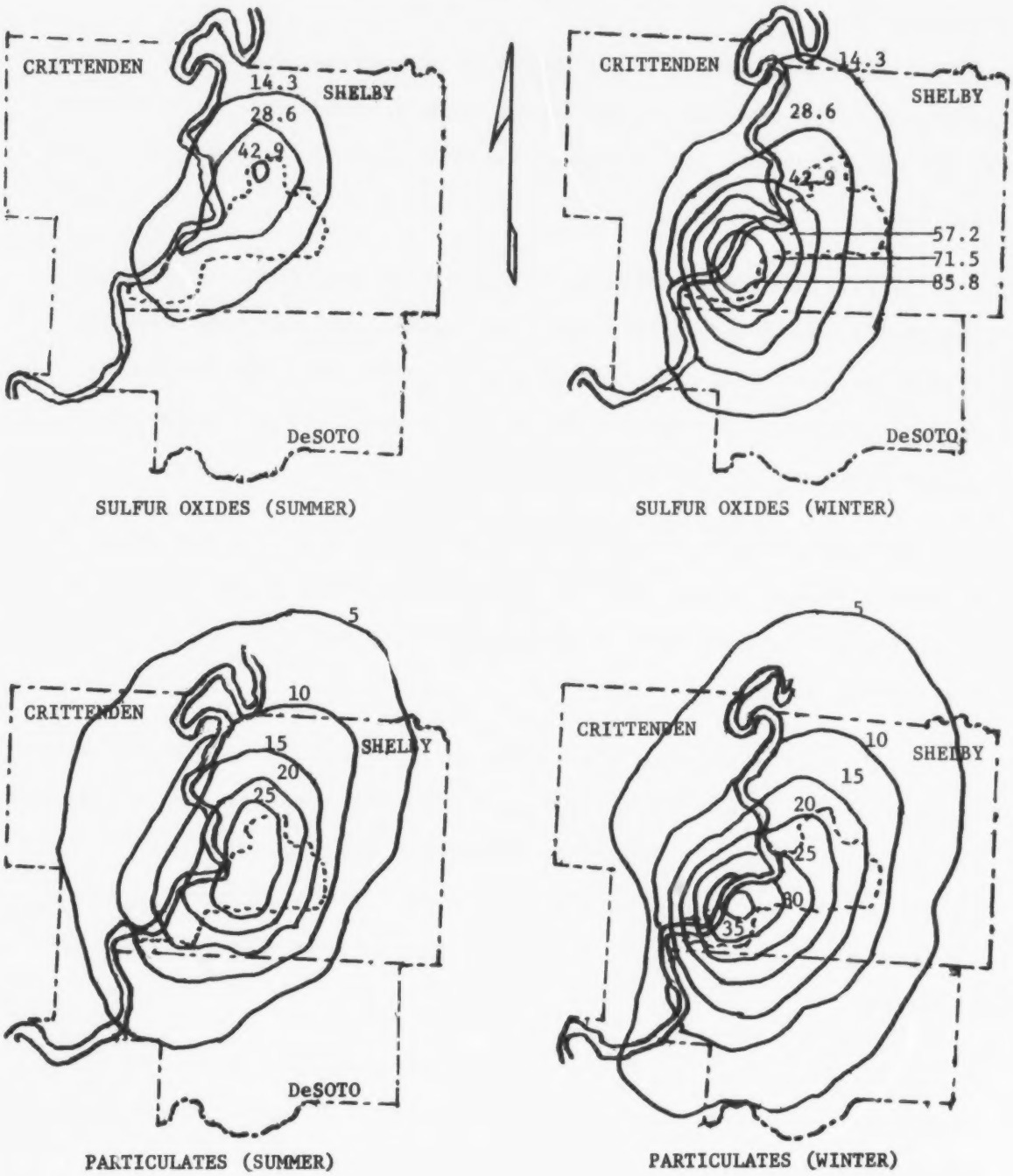


FIGURE 12- Theoretical Concentrations: Sulfur Oxides and Particulates in the Memphis Area. Values in Micrograms Per Cubic Meter

as the power generation plant turns to use of natural gas. Even in the winter, when the power plant is coal-burning, the isopleth at 14.3$\mu g/m^3$ shows concentration only within the three-county Region.

Particulate dispersion also centers in the south of Memphis near the steam generation plant and, again, the northward shift in the summer is seen. The 10$\mu g/m^3$ isopleth extends into the southwest corner of Tipton County (Tennessee) and the southern end of Mississippi County (Arkansas).

Because of lack of industrialization outside the three-county Region, it is doubtful that an expanded emission inventory would significantly change this distribution in either the Tennessee or Mississippi counties.

Air quality sampling conducted in the Memphis area in 1968 shows similar concentration in the urbanized areas in and around the City of Memphis. Table XII indicates the distribution of particulates over 8 sampling stations operated continuously in January and December 1968, and on a random basis during the other 10 months.

Stations 1 through 5 were located within the Memphis city limits; 6 was immediately north of the city, 7 to the south near the Mississippi line, and 8 to the north in Shelby County.

The geometric mean quantity of suspended particulates in the downtown area ranged from 84 to 96$\mu g/m^3$. The farthest south

TABLE XII SUSPENDED PARTICULATE 1968

Micrograms per cubic meter

Frequency Distribution

Sta.	Samples	Min	10	20	30	40	50	60	70	80	90	Max	Arith. Mean	Geo. Mean
1	139	24	42	54	64	75	80	103	112	137	153	226	95	86
2	164	11	35	48	59	67	78	83	96	107	125	328	77	84
3	112	21	31	41	51	61	68	78	85	93	108	181	84	95
4	175	11	38	53	68	82	92	106	128	153	230	392	107	96
5	154	23	37	54	64	73	83	94	104	118	137	229	90	88
6	146	19	38	50	61	70	79	91	100	119	150	232	80	78
7	131	6	22	30	36	43	49	55	63	71	93	122	53	49
8	156	11	22	30	37	44	53	60	72	84	101	146	51	57

Source: Memphis-Shelby County Health Department

station showed 49 $\mu g/m^3$, and to the north, mean concentrations of 78 and 57 μg were observed.

These concentrations can be compared to urban averages from the National Air Surveillance Network (NASN), which has found annual geometric mean concentrations of suspended particulate matter to range from 60 $\mu g/m^3$ to about 200 $\mu g/m^3$ in urban areas generally.

While measured air quality from these sampling stations is considerably higher than the theoretical results of the model, the distribution curves of the model appear to be consistent with actual measurement.

Meteorology

In order to relate sources of pollution to affected areas, and to understand better the movement of pollutants through the Region, it is necessary to examine the Region's weather characteristics.

As described in other sections of the Report, the topography of the region, varying from the level flood plain area of east Arkansas to the slightly rolling area of northwest Mississippi and southwestern Tennessee, does not significantly affect major weather systems.

The average annual temperature of the region is in the low sixties, and ranges from the low forties in January to the low eighties in July. Precipitation of about 50 inches per year is fairly well-distributed.

The region is not in the normal paths of either Gulf or western Canadian storms, although its weather is affected by both and, therefore, changes rather frequently. Extremely high or low temperatures are rare, with about 70 days per year having maximum temperature over 90 degrees and only about 55 days under 32 degrees. Winds tend to be light and variable, but in winter, generally, will be either south, southwest, or north when influenced by Canadian air masses; and in summer tend to be principally from the south or southwest. On the average, winds are most likely to be from the south or southwest at speeds of less than 4-1/2 meters per second. Lowered mixing depths in the morning, coupled with relatively slight south winds, have caused episodes of visible air pollution in the region which resulted in media attention and citizen complaints. Such episodic conditions are not demonstrated by the model.

The frequency of low-level inversions at Memphis is slightly more than 35 percent of the total hours in the year. This means that during one-third of the hours of the year (and most of these hours occur at night), there is an inversion base at the surface or within 500 feet of the surface. Vertical motion is inhibited within or at the base of an inversion. This frequency is higher than the National average.

Prolonged periods of stagnation conditions, i.e., periods of four or more consecutive days during which there is very little wind movement, are considered periods of high air pollution potential.

Over a period of thirty years, 1936-65, Memphis has experienced approximately 26 stagnation periods in which a total of 120 days were involved. Since this averages less than one each year, prolonged periods of stagnation are not considered a major problem in Memphis. The most likely time when one of these stagnations would occur is October, and there is very little likelihood that one would occur during December through April.

Figure 13 shows the wind roses for the summer, winter, and annually for the Memphis area. They represent graphically the frequency of occurrence of the wind from the various compass directions. These data, along with effective wind speeds for the respective compass directions, were used as input data for the computerized model. The characteristic prevailing wind directions for each of the seasons, shown by the length of the wind rose radials, influence the dispersion of pollutants. This relationship may be observed by correlating the shapes of the concentration isopleths for the pollutants and the wind rose for the appropriate averaging time.

Table XIII shows average mixing depths for the winter, summer, and annual seasons. Note the significant diurnal variations in the mixing depth. These mixing depths define the volume of air above the surface through which pollutants mix. For purposes of the model, mixing depth is assumed to be constant over the receptor grid system.

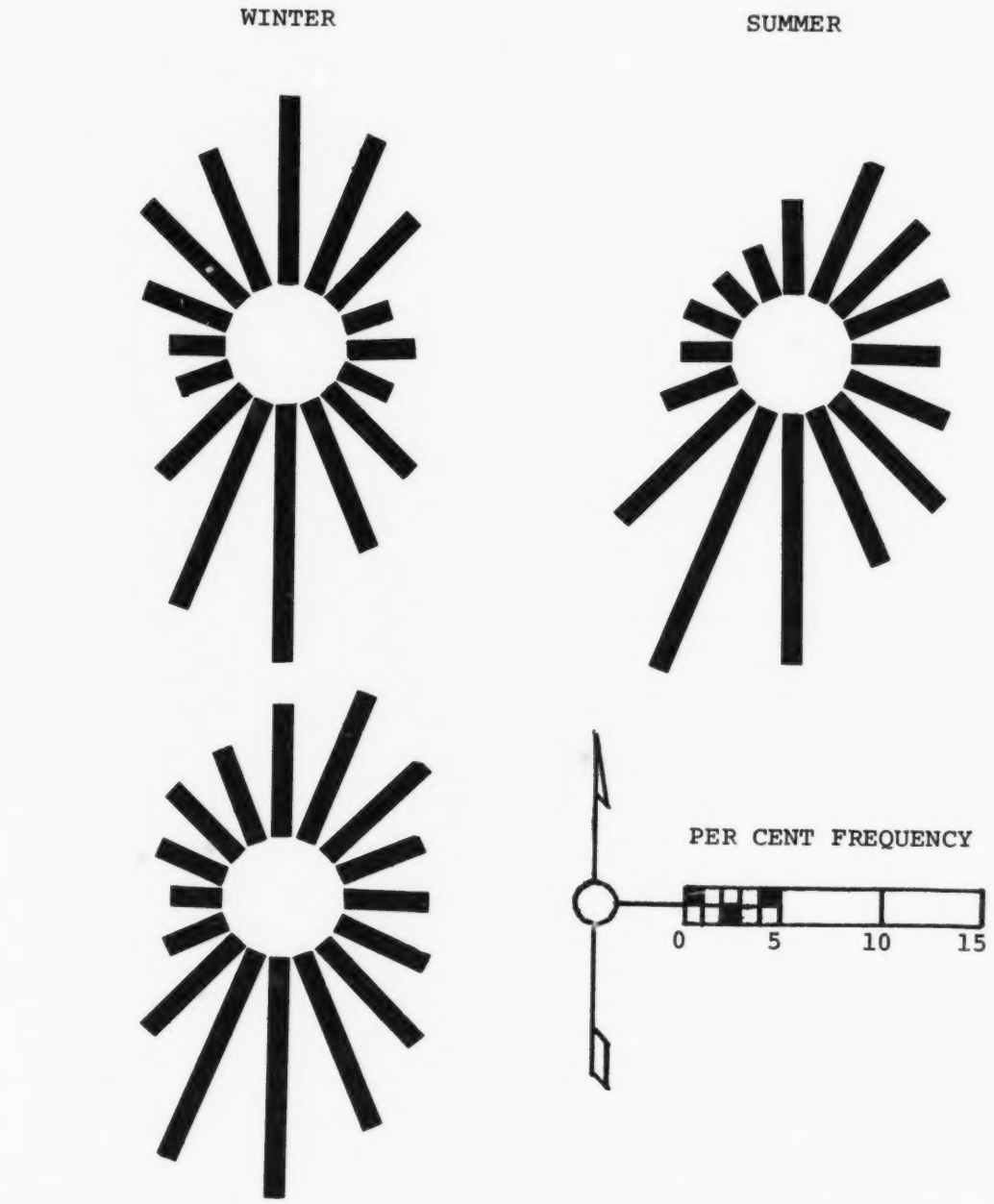


FIGURE 13 - WIND DIRECTION PER CENT FREQUENCY OF OCCURRENCE FOR VARIOUS AVERAGING TIMES

TABLE XIII

Mixing Depth
(meters)

	Winter	Summer	Annual
Morning	445	380	400
Afternoon	1,020	1,830	1,470
Average	735	1,105	935

PROPOSED MEMPHIS AIR QUALITY CONTROL REGION

Subject to the scheduled consultation, it seems appropriate to consider an air quality control region for the Memphis region consisting of three counties:

Shelby County (Tennessee)
DeSoto County (Mississippi)
Crittenden County (Arkansas)

This proposed Memphis Interstate Air Quality Control Region would consist of all of the area encompassed by the outermost boundaries of the proposed counties. Figure 14 illustrates the region.

Discussion

An air quality region should meet three basic conditions:

1. It should encompass most pollution sources as well as most people and property affected by the sources;
2. It should include those areas where industrial and residential growth may create significant future problems;
3. It should be consistent with unified and cooperative governmental administration of the region's air resources.

The Technical Factors Evaluation section of this Report discussed the first condition; the remaining sections of the Report deal with the latter two.

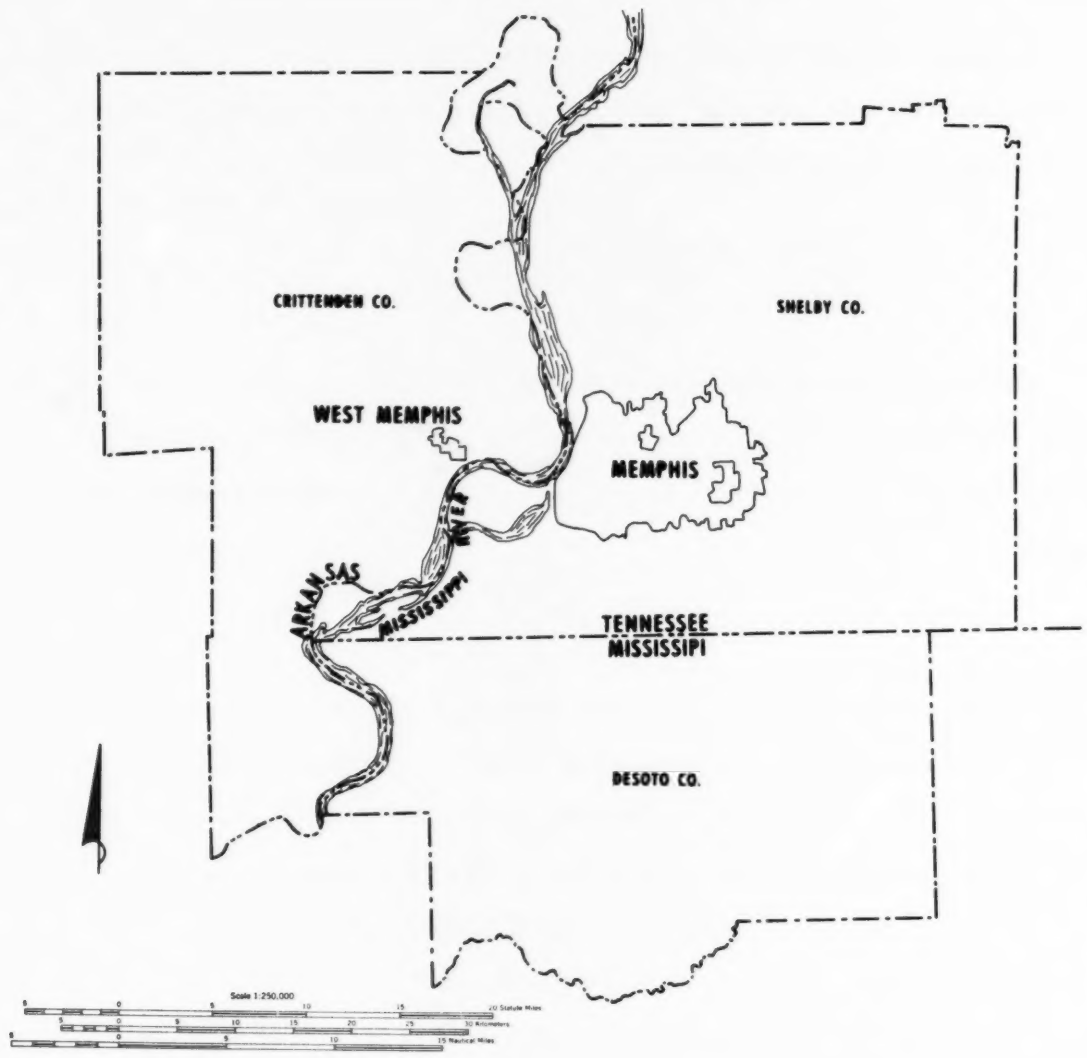


FIGURE 14 - Proposed Memphis Air Quality Region.

The diffusion maps, taken together with the emission inventory and the highway system, show that the principal sources and most of the effects are centered in Shelby County, Tennessee, with impact on the people and property also felt in DeSoto County, Mississippi, and Crittenden County, Arkansas. While the diffusion maps show some effects in southern Tipton County (Tennessee) and Mississippi County (Arkansas), it is not believed that they are of sufficient magnitude to warrant inclusion on this ground alone.

In terms of future growth of the area, it seems clear that low population densities within the proposed Region and outside the urbanized Memphis area are adequate to absorb additional population and industry in the near future. It would also be expected that, with the establishment of the Memphis Interstate Air Quality Control Region, the probability of significant increase in air pollution in the area would be substantially lessened because of the development of control and abatement programs.

At the same time, however, a continuing review of development on the perimeter of the proposed Region, and in the adjoining counties, should be conducted. This is particularly important when the outer ring highway system proposed in the long-range transportation study is constructed.

Additionally, although not covered in this Report, there is some indication that the Blytheville, Arkansas, area (in Mississippi County, Arkansas, northwest of Memphis) is developing as an industrial center. Future consideration of Mississippi County as a part of the Region will depend on the extent of this development.

This Report, then, while indicating a three-county Region at this time, suggests continuing evaluation of possible future inclusion of Tipton County (Tennessee), Marshall County (Mississippi), or Mississippi County (Arkansas).

The **proposed** three-county Region offers the best possibility at this time for the development of an effective regional effort to prevent and control air pollution in the Memphis area. It has organized a Council of Governments (MATCOG), and has provided a framework for intergovernmental cooperation. It is cohesive in terms of its transportation system, employment and other economic and demographic indicators. And it includes within its boundaries substantially all of the sources and effects both now and in the immediate future.